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## (54) Title: TRANSPARENT CONDUCTIVE LAMINATE AND DISPLAY

(57) Abstract: A transparent conductive laminate comprises a transparent fluorine-containing resin film, a transparent gas barrier layer formed on one side of the fluorine-containing resin film, and a transparent conductive layer which is formed on either the other side of the fluorine-containing resin film or the gas barrier layer.

(57) Abstract (Translation of abstract in source document): A transparent conductive laminate having a transparent fluorine-containing resin film, a transparent gas barrier layer formed on one side of this fluorine-containing resin film, and a transparent conductive layer formed on the other side of this fluorine-containing resin film or on the gas barrier layer.

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Figure 1

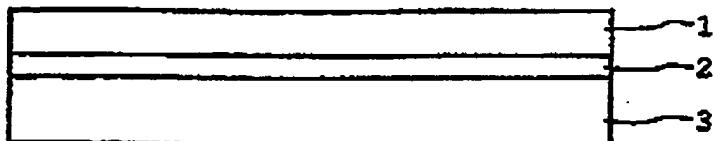


Figure 2

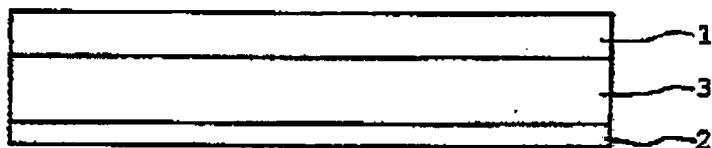


Figure 3

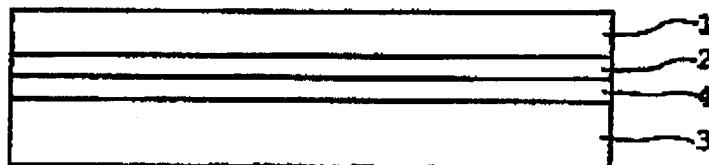


Figure 4

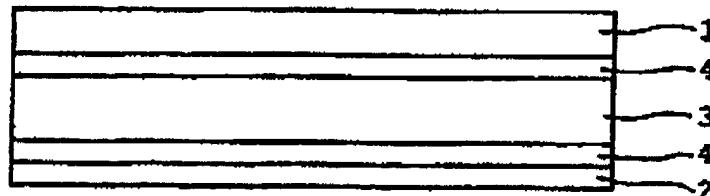


Figure 5

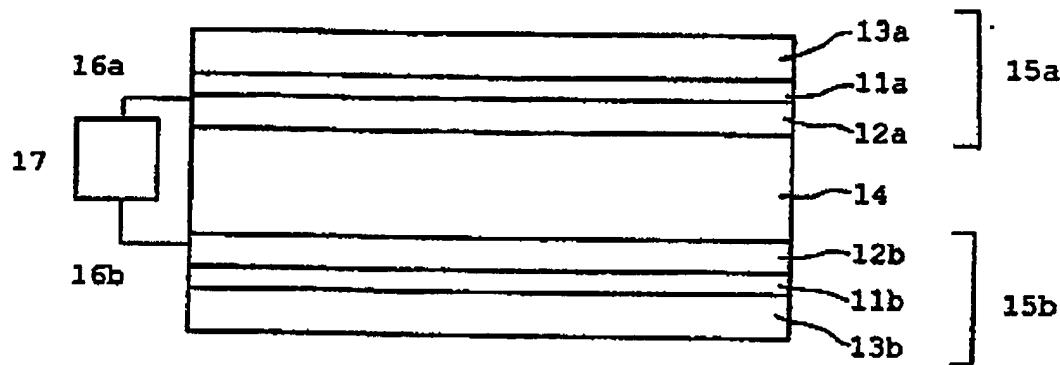
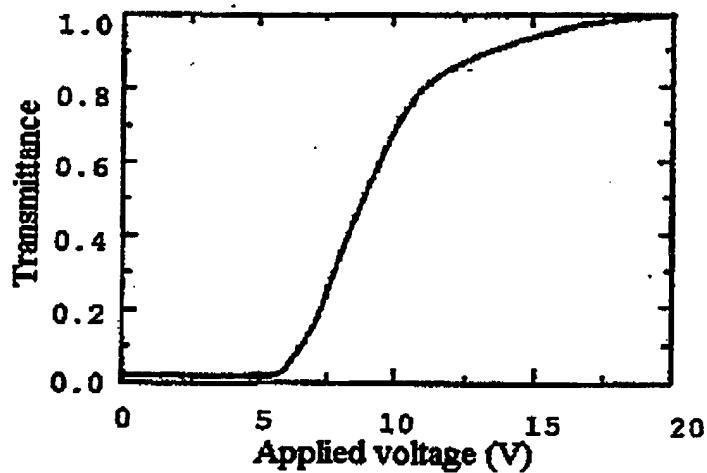


Figure 6



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TECHNICAL FIELD

The present invention relates to a transparent conductive laminate and a display.

BACKGROUND ART

Glass provided with a transparent electrode has primarily been used as the transparent substrate that holds the display medium in the panels of displays such as liquid-crystal displays, electrophoresis displays, electrodeposition displays, organic electroluminescence displays, and dispersion-type inorganic electroluminescence displays. Development is currently advancing, however, toward the use of transparent resin films as the substrates of such displays because of advantages such as light weight, thinness, and resistance to breakage.

The conventional transparent resin films used in transparent electrodes include polycarbonate (PC), polyarylate (PAR), polyethersulfone (PES), and polyethylene terephthalate (PET), which have superior optical properties such as optical transmittance. A gas barrier layer and transparent conductive layer are generally formed on the transparent resin film in transparent substrates that employ these resins, and those described in JP Kokai 6-196023, 8-323912, and 10-24520 are known. The substrate of a fluorine film provided with a transparent conductive layer that is described in JP Kokai 57-88430 is also known as a substrate obtained using other than the aforementioned transparent resin films.

The process for the production of a transparent substrate obtained using a transparent resin film and a display is as follows. After bonding a transparent conductive layer of a metal oxide film to the transparent resin film by vacuum vapor deposition or sputtering accompanied by heating of the substrate, a resist solution is applied with a roll coater, spin coater, or the like, and the resist is masked by a patterned glass. The resist is exposed and developed thereafter by ultraviolet rays, and the transparent conductive film is etched by removing the photosensitive parts. After etching, the resist is stripped away using an alkali such as NaOH, and the alkali is washed away thoroughly.

For a liquid-crystal display, a resin such as polyimide is also applied to the transparent substrate on which the transparent electrode has been formed to serve as the orientation film. After baking at a high temperature, the film is rubbed. A spacer material is sprayed on the inside

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of the panel of one substrate, a seal material is printed onto the perimeter of the substrates, and the two substrates are pasted together. Liquid liquid-crystals are finally injected under a vacuum into the gap between the glued substrates to produce the display panel.

In an electrophoresis display or an electrodeposition display, the panel is made by sandwiching an electrolytic solution that contains metal ions, as well as an ink that contains electrophoretic particles, between the substrates.

In other self-luminous displays, the display panel is constructed by bonding a luminous material to a single transparent substrate because the display medium need not necessarily be interposed between two transparent substrates.

However, conventional displays that use transparent resin films have the following problems.

(1) When the flexural modulus is used as an indicator of the mechanical properties of the transparent substrate, a substrate with a modulus of 200 kg/mm<sup>2</sup> or more is preferably used as the transparent substrate of a conventional transparent resin film. The lack of flexibility, however, makes application to curved displays difficult. This lack of flexibility also makes this substrate inapplicable to reel displays with superior portability and storage.

(2) A high-temperature process is needed to form the transparent electrode and orientation film on the transparent resin film (for example, the substrate must be heated to 100°C or higher to form a transparent conductive film with low electrical resistance; a heat treatment at around 200°C is essential to form the orientation film necessary for a liquid-crystal display). However, the heat resistance of the transparent resin film is low, and decreases in surface resistivity and physical deformation such as warping cause the flatness to deteriorate. The display production yield declines markedly as a result.

(3) Acids, alkalis, and various organic solvents are used in the process of assembling the display panel, patterning the transparent electrode, forming the orientation film, and washing. The transparency of transparent resin films with inferior solvent resistance, however, is harmed by dissolution and deterioration (whitening). This reduces the display properties such as the brightness and contrast.

(4) Transparent substrates that employ conventional transparent resin films have an inadequate gas barrier property. The ingress of air has a deleterious effect on the display. The high moisture absorptivity and the tendency to be affected by the moisture in the air also lower the reliability of the display by causing deterioration of the display medium.

#### DISCLOSURE OF THE INVENTION

An object of the present invention is to provide a transparent conductive laminate that has excellent properties such as solvent resistance and weather resistance together with high heat resistance, low elasticity, and low water absorptiveness, and to provide a display that uses this laminate.

According to one aspect of the present invention, there is provided a transparent conductive laminate comprising a transparent fluorine-containing resin film, a transparent gas barrier layer formed on one side of this fluorine-containing resin film, and a transparent conductive layer formed on the other side of this fluorine-containing resin film or on the gas barrier layer.

According to another aspect, the present invention provides a display in which a display medium with an overall gaseous, liquid, or solid form is held between transparent substrates, wherein at least one of the transparent substrates consists of the aforementioned transparent conductive laminate.

The present invention also provides a display in which a display medium composed of thin films is laminated on top of a transparent substrate, wherein this transparent substrate consists of the aforementioned transparent conductive film.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is explained in detail below with reference to the following drawings. In the drawings:

Figure 1 is a cross-sectional diagram that schematically shows one embodiment of the transparent conductive laminate of the present invention;

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Figure 2 is a cross-sectional diagram that schematically shows another embodiment of the transparent conductive laminate of the present invention;

Figure 3 is a cross-sectional diagram that schematically shows yet another embodiment of the transparent conductive laminate of the present invention;

Figure 4 is a cross-sectional diagram that schematically shows yet another embodiment of the transparent conductive laminate of the present invention;

Figure 5 is a cross-sectional diagram that schematically shows one embodiment of the display of the present invention; and

Figure 6 is a diagram that shows the relationship between the voltage applied and the optical transmittance in the display of the present invention.

#### BEST MODE FOR CARRYING OUT THE INVENTION

The transparent conductive laminate of the present invention (also referred to simply as laminate hereinafter) includes a transparent fluorine-containing resin film as the substrate. Various conventional, known types can be used as this fluorine-containing resin film. Examples include films made of one or more types of fluorine-containing resin, such as polytetrafluoroethylene (PTFE); tetrafluoroethylene and hexafluoropropylene copolymer (FEP); perfluoroalkoxy resin (PFA) made of a copolymer of tetrafluoroethylene and perfluoroalkyl vinyl ether; tetrafluoroethylene, perfluoroalkyl vinyl ether, and hexafluoropropylene copolymer (EPE); copolymer of tetrafluoroethylene and ethylene or propylene (ETFE); polychlorotrifluoroethylene resin (PCTFE); copolymer of ethylene and chlorotrifluoroethylene (ECTFE); vinylidene fluoride-based resin (PVDF); and vinyl fluoride-based resin (PVF).

This transparent fluorine-containing resin film has a thickness of 5-500 µm, preferably about 20-250 µm. Its optical transmittance at a wavelength of 550 nm is preferably 80% or higher.

The laminate of the present invention includes a transparent conductive layer. This transparent conductive layer is formed from a conventional, known transparent conductive

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material. A metal oxide such as indium oxide-tin oxide (ITO), indium oxide, tin oxide, zinc oxide, antimony oxide, indium oxide-gallium oxide, indium oxide-zinc oxide, or indium oxide-aluminum oxide is preferably used as the transparent conductive material in this case. The transparent conductive layer is formed by a technique such as CVD, vacuum vapor deposition, ion plating, or sputtering using an inorganic transparent conductive material such as a metal oxide. Sputtering and ion plating are preferred as the method of forming this transparent conductive layer in consideration of the adhesion to the substrate. Sputtering is especially preferred.

A transparent organic conductive material such as a polythiophene-based resin may also be used as a transparent conductive film other than a metal oxide applied to the transparent fluorine-containing resin film by a means such as spin coating or printing.

This transparent conductive layer has a thickness of 50-2000Å, preferably 100-1500Å. Its surface electrical resistance is 10-500 Ω/cm<sup>2</sup>, preferably 10-100 Ω/cm<sup>2</sup>.

The laminate of the present invention contains a transparent gas barrier layer. This transparent gas barrier layer can be formed from a conventional, known gas barrier material. Oxides of metals such as silicon, aluminum, magnesium, zinc, and zirconium are used as this gas barrier material. SiO<sub>x</sub> (1.5≤x≤2.0) is especially preferred from the viewpoints of transparency, mechanical properties, and gas barrier property. The proportion of oxygen to silicon in the silicon oxide here is confirmed by a method such as x-ray photoelectron spectroscopy or Auger photoelectron spectroscopy.

This transparent gas barrier layer has a thickness of 50-2000Å, preferably 100-1000Å.

Conventional, known surface treatments can be carried out on one or both sides of the fluorine-containing resin film to improve the adhesion with each layer in the present invention. Examples of such surface treatments include UV treatment, plasma treatment, and corona treatment.

A primer layer can also be formed on one or both sides of the fluorine-containing resin film to improve the adhesion with each layer in the present invention. The primer layer can be

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formed on the untreated surface of the fluorine-containing resin film, but it is preferable to form the layer on a surface that has undergone surface treatment.

The primer layer is formed from a conventional, known primer material. Examples of the primer material include various adhesive materials such as epoxy-based resin, acrylic-based resin, polyester-based resin, polyamide-based resin, urethane-based resin, phenol-based resin, silicone-based resin, polysilane-based resin, fluorine-based resin, ethylene-vinyl alcohol-based resin, and vinyl chloride-vinyl acetate-based resin.

This primer layer has a thickness of 0.01-20  $\mu\text{m}$ , preferably 0.1-20  $\mu\text{m}$ .

The transparent conductive film of the present invention is produced by a conventional, known method. The method of production is not particularly restricted as long as it is a method that gives the prescribed laminate.

Figures 1-4 show layer construction diagrams of the transparent conductive laminate of the present invention.

In these diagrams, 1 is the transparent conductive layer, 2 is the transparent gas barrier layer, 3 is the transparent fluorine-containing resin film, and 4 is the primer layer.

The primer layer 4 is formed on the surface of the transparent fluorine-containing resin layer, the adhesion of which has been improved by surface treatment.

The flexural modulus is 1-100 kg/mm<sup>2</sup>, preferably 10-50 kg/mm<sup>2</sup>, in the transparent conductive laminate of the present invention.

The optical transmittance of the laminate at a wavelength of 550 nm is 80% or higher, preferably 85% or higher. The moisture absorptivity of the laminate is 0.1% or less, preferably 0.01% or less. The thickness of the laminate is 5-500  $\mu\text{m}$ , preferably 20-250  $\mu\text{m}$ . The conductivity of the laminate, expressed as the surface resistivity, is 10-500  $\Omega/\text{cm}^2$ , preferably 10-100  $\Omega/\text{cm}^2$ .

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The optical transmittance of the laminate of the present invention at a wavelength of 550 nm after being heat treated in air for two hours at 220°C is 80% or higher, and this heat treatment does not change the appearance of the laminate.

The transparent conductive laminate of the present invention can be used as at least one of the transparent substrates in a conventional, known display of a construction in which a display medium of an overall entirely gaseous, liquid, or solid form is held between a pair of transparent substrates.

The transparent conductive laminate of the present invention can also be used as a transparent substrate in a conventional, known display of a construction in which a display medium composed of a thin film is laminated on a transparent substrate.

Conventional, known display media, the overall form of which is gaseous (including those that contain solid particles or liquid particles in a gas), liquid (including those that contain solid particles in a liquid), or solid (including those that contain liquid particles and solid particles in a solid), can be used as the display medium in the display of the present invention without any particular restrictions.

Such a display medium can be liquid crystals that modulate the incident light by changes in optical properties and changes in molecular orientation in accordance with the applied voltage as disclosed, for example, by Arisawa, Kobayashi, Koshimizu, Kakinuma, Harada, Maruyama, and Baba in "Electronic paper using cholesteric liquid crystals—writing of optical images on organic photosensitive media," *Japan Hardcopy 2000 collection*, pp. 89-92 (2000) and T. Ohide, M. Higa, and K. Fujimura in "A black/white reflective type STN-LCD using polymer film substrates," *Proc. Asia Disp.*, p. 1.2-1, pp. 169-172 (1995). Displays that contain such liquid crystals can have a transmission or reflection display construction in which the display behavior is modulated by the transmitted light or reflected light. Nematic liquid crystals, cholesteric liquid crystals, smectic liquid crystals (including strongly dielectric liquid crystals capable of rapid movement), and the like can be used as the liquid crystal material. The starting alignment of the liquid crystal molecules can be regulated to homeotropic (vertical) alignment, homogenous (horizontal) alignment, twisted alignment, pi alignment, or hybrid alignment that combines vertical and horizontal alignment or the like by the action of the orientation film (such as a

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rubbed polyimide film) on the transparent electrode. However, it is not necessarily limited to these alignments.

A display medium can also be obtained using a composite film having a fine polymer structure (such as acrylic resin or urethane resin) formed in liquid crystals as disclosed by J.W. Doane, N.A. Vaz, B.G. Wu, and S. Zumer in "Field-controlled light scattering from nematic microdroplets," *Appl. Phys. Lett.*, Vol. 48, No. 4, pp. 269-271 (1986); and N.A. Vaz, G.W. Smith, and G.P. Montgomery, Jr. in "A light-control film composed of liquid crystal droplets dispersed in a UV-curable polymer," *Mol. Cryst. Liq. Cryst.*, Vol. 146, pp. 1-15 (1987). These polymers play the role of maintaining a uniform space, i.e., the composite film thickness, between the two transparent substrates when the display is bent or when outside force is applied. Photopolymerization, heat polymerization, phase-separation techniques that use solvent evaporation, impregnation techniques that impregnate a porous resin with liquid crystals, and other techniques are useful as methods of forming the composite film of liquid crystals and polymer. Those that contain droplets of liquid crystals and various polymer structures such as networks, particles, and walls can be used as the polymer morphology. Light modulation becomes possible without the use of a polarization plate, and a bright display can be constructed because the intensity of scattering changes depending on the liquid crystal alignment when light scattering is strong in the composite film in a display with this composite film.

A polarization plate sometimes becomes necessary in a liquid crystal display to make the polarization of the incoming and outgoing light uniform in the display. This polarization plate can also be integrated into the display by a means such as affixing the display to the transparent substrate.

Display media other than liquid crystals include those containing electrophoretic particles that change the state of absorption of outside light by movement or rotation of colored or white microparticles (such as a pigment) in the liquid or gas sandwiched between the substrates by static electrical force accompanying the application of voltage, as disclosed by B. Comiskey, J.D. Albert, H. Yoshizawa, and J. Jacobson in "An electrophoretic ink all-printed reflective electronic display," *Nature*, 394, pp. 253-255 (1998); and K. Amundson, J. Ewing, P. Kazias, R. McCarthy, J.D. Albert, R. Zehner, and P. Drzaic in "Flexible, active-matrix display constructed using a

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microencapsulated electrophoretic material and an organic semiconductor-based backplane," *SID01 Digest*, pp. 160-163 (2001). The type of electrophoretic display that utilizes electrophoretic particles is provided with two oppositely disposed electrodes that form the electrode pattern necessary for the display by using a transparent conductive material such as ITO. A disperse system of the electrophoretic particles dispersed in a liquid dispersion medium is sealed between the oppositely disposed electrodes that are equipped with spacers, and the perimeter is sealed.

Another example of obtaining an electrodeposition effect that controls the ionization and deposition of a metal (such as silver) in an electrolyte by injection of an electric current from a transparent conductive layer is disclosed by K. Shinozaki in "Electrodeposition device for paper-like display" *SID02 Digest*, pp. 39-41 (2002).

Another display medium is an organic thin film that emits light due to current injection from a transparent conductive layer as disclosed by C.W. Tang and S.A. Van Slyke in "Organic electroluminescent diode," *Appl. Phys. Lett.*, 51, pp. 913-915 (1987). A flexible organic electroluminescent display can be constructed easily if this organic thin film is used. There are three basic electroluminescence structures: single layer, single hetero, and double hetero. The single layer structure is the simplest of the three. One organic layer plays all of the roles of hole transport, electron transport, and luminescence. A multi-layered structure is often used in polymer-based organic EL, but since the injected carrier cannot be sealed within the element, it is difficult to optimize the carrier balance, and the efficiency decreases in comparison to the other structures. A single hetero structure attains high luminance and efficiency by separating hole and electron injection and transport into two layers. The double hetero structure is the element structure with the greatest separation of functions. The element is constructed of three layers: a hole transport layer, a luminescence layer, and an electron transport layer. The electrons and holes are transported within their respective corresponding transport layers and injected into the luminescence layer.

To explain the mechanism by which organic electroluminescence operates using a single hetero structure as the example, holes and electrons are first injected in the hole transport layer from the anode and transported to the interface of the electron-transporting luminescence layer.

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The electrons are injected and transported in the electron-transporting luminescence layer from the cathode. The holes and electrons that have been injected and transported recombine in either the hole transport layer or the electron transport layer. Which of the two is the recombination zone is decided by the mutual energy levels and the charge transport capacity. Luminescence is obtained when the organic molecules excited by the recombination of these holes and electrons return to the ground state.

A dispersion-type electroluminescence display can also be constructed if a resin film containing a dispersed inorganic fluorescent material that emits light upon application of an electrical field is used as the display medium. Only one of the substrates need be transparent in reflection-type liquid-crystal displays and electrophoresis displays that utilize outside light, and in self-luminescent organic electroluminescence displays and dispersion-type electroluminescence displays. Two transparent substrates that contain a transparent gas barrier layer, transparent conductive layer, and fluorine-based transparent resin film therefore need not necessarily be used. One transparent substrate may be used in this case.

Figure 5 shows a diagram that explains the construction of the display of the present invention.

In Figure 5, 11a and 11b are transparent gas barrier layers, 12a and 12b are transparent conductive layers, 13a and 13b are transparent fluorine-containing resin films, 14 is the display medium, 15a and 15b are transparent substrates, 16a and 16b are lead wires, and 17 is a driving power source.

The display of the present invention has low elasticity, high heat resistance, solvent resistance, and low water absorptiveness, and is a display with a flexible structure that has excellent display properties, reliability, and production yield because it contains a substrate made of the transparent conductive laminate of the present invention.

Figure 6 is a graph that shows the relationship between the applied voltage (V) and the transmittance in an example of a liquid-crystal display of the present invention.

The present invention will be explained in greater detail below through working examples. The display transparent substrates were evaluated by measuring the following properties.

[Total light transmittance] The light transmittance was measured at a wavelength of 550 nm using a UV-2400PC (made by Shimadzu).

[Surface resistivity] The surface resistivity was measured by the four-terminal method using a Loresta-GP MCP-T600 (made by Mitsubishi Chemical).

[Heat resistance] The changes in the properties and appearance were studied after heating for 2 hours at 220°C in a dryer and cooling to room temperature.

[Flexural modulus] A silicon oxide transparent gas barrier layer (100Å thick) and a transparent conductive ITO layer (1500Å thick) were laminated in that order in the same way as in the working examples on a 3 mm thick film substrate obtained by laminating transparent fluorine-based transparent resin films, and a transparent conductive substrate was produced to measure the flexural modulus. The flexural modulus of this transparent conductive substrate was measured using the method described as the test method for the bending properties of plastics in JIS K-7121.

#### Working Example 1

A fluorine resin (Neoflon™ PFA AP-201) made by Daikin was melted in a biaxial extruder (screw diameter 15 mm) and extruded into a film from a T-die (lip length 150 mm, lip clearance 0.6 mm, die temperature 340°C) at the tip of the extruder, and a 200 µm thick transparent fluorine-containing transparent resin film was obtained by cooling.

A transparent silicon oxide barrier layer (100Å thick) and a transparent conductive ITO layer (1500Å thick) were layered in that order on one side of this substrate by sputtering, and a transparent conductive substrate for a display was produced. The sputtering conditions were as follows.

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## (Silicon oxide layer)

Target	SiO <sub>2</sub>
Gas introduced	Ar or O <sub>2</sub>
Sputtering vacuum	2.0 × 10 <sup>-3</sup> Torr
Power input	3.0 kW
Substrate temperature	100°C

## (ITO layer)

Target	ITO (In <sub>2</sub> O <sub>3</sub> :SnO <sub>2</sub> = 9:1)
Gas introduced	Ar or O <sub>2</sub>
Sputtering vacuum	2.0 × 10 <sup>-3</sup> Torr
Power input	0.3 kW
Substrate temperature	100°C

## Working Example 2

A transparent conductive substrate for a display was obtained in the same way as in Working Example 1 except that 100 µm thick PFA (Neoflon™ PFA Film AF-0100) made by Daikin was used as the transparent fluorine-containing resin film.

## Working Example 3

A transparent conductive substrate for a display was obtained in the same way as in Working Example 1 except that 100 µm thick FEP (Neoflon™ FEP Film NF-0100) made by Daikin was used as the transparent fluorine-containing resin film.

## Comparative Example 1

The properties of a 125 µm thick commercial transparent conductive substrate (OTEC made by Oji Tobi) that used PET as the substrate film were checked.

## Working Example 4

A liquid-crystal display was produced using the transparent conductive substrate obtained in Working Example 1. First, plastic beads (particle diameter 25 µm) were applied uniformly to

the transparent conductive substrate. A sealing adhesive (epoxy-based transparent adhesive) was then applied to the four edges of the transparent conductive substrate. A hole was left open at this time as an injection port for the liquid crystals to be injected later. The transparent substrates were stacked and glued together by bonding the sealing material by means of UV rays. A mixture of liquid crystals and a UV-curable monomer (PNM-103 made by Dai-nippon Ink) was then injected from the liquid crystal injection port, and a composite film of liquid crystals and resin was formed between the substrates by depositing a fine mesh-like resin in the liquid crystals by applying UV rays. Figure 6 shows the results obtained by measuring the relationship between the voltage strength applied between the ITO and light transmittance. High contrast display behavior was confirmed. The liquid-crystal display obtained had excellent flexibility and could bend easily.

Table 1 shows the properties of the transparent conductive substrates of the displays obtained in Working Examples 1-3 and Comparative Example 1. High flexibility can be imparted to the display because the flexural modulus of the transparent substrate can be decreased to 1/3 or less of the conventional value of 200 kg/mm<sup>2</sup> by the use of a flexible transparent substrate made of a transparent gas barrier layer, a transparent conductive layer, and a transparent fluorine-containing resin film. The problems of decreased light transmittance, increased electrical resistance, and deformation of the substrate caused by heat treatment (220°C) were also resolved because a heat-resistant transparent fluorine-containing resin film was used in the substrate. The water content of the air has little effect because the moisture absorptivity is less than 0.1%, and the reliability of the display is also improved. When acids and alkalis were used in patterning of the transparent electrodes and the like, the fluorine-based transparent resin film had excellent resistance to these solvents. Deterioration of the substrate by UV rays was also not a problem, and the weather resistance was excellent.

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Table 1

	Flexural modulus (kg/mm <sup>2</sup> )	Moisture absorptivity (%)	Before heat treatment	After heat treatment	Before heat treatment	After heat treatment	After heat treatment
			Surface resistivity (Ω/□)		Light transmittance (%)		Appearance
Working example 1	65	<0.01	36	36	85	85	No change
Working example 2	65	<0.01	36	36	85	85	No change
Working example 3	55	<0.01	36	36	89	89	No change
Comparative example 1	300	0.5	53	218	73	56	Cloudy

The transparent conductive laminate (transparent conductive composite sheet) of the present invention has better flexibility than those that use conventional polymer films because it uses a transparent fluorine-containing resin film as its substrate, and a curved display became possible when the laminate was used as the substrate of a liquid crystal display. Since the transparent conductive laminate of the present invention contains a heat-resistant transparent fluorine-containing resin film, a light transmittance of liquid crystal display in which the laminate is used as a substrate is not affected by heat treatment, and deterioration of the substrate film during the high-temperature process of orientation film production ceases to be a problem. Furthermore, when acid and alkalis are used in patterning of the electrodes and the like, the transparent conductive laminate of the present invention has excellent resistance to these solvents. Deterioration of the substrate by UV rays is also not a problem, and the weather resistance is also excellent. Since the moisture absorptivity is less than 0.1%, the water content of the air has little effect, and the reliability of the liquid-crystal display itself can also be improved.

Low elasticity, high heat resistance, solvent resistance, and low water absorptiveness can be assured and a flexible display with excellent display properties, reliability, and production yield can be provided by using the transparent fluorine-containing resin film provided with a transparent conductive layer and transparent gas barrier layer according to the present invention as the transparent substrate for holding the display medium.

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CLAIMS

1. A transparent conductive laminate comprising a transparent fluorine-containing resin film, a transparent gas barrier layer formed on one side of the fluorine-containing resin film, and a transparent conductive layer formed on the other side of the fluorine-containing resin film or on the gas barrier layer.
2. The transparent conductive laminate of Claim 1, wherein the conductive layer is formed on the gas barrier layer, and the surface of the fluorine-containing resin film on the side of the gas barrier layer is submitted to surface treatment to improve the adhesion of the film.
3. The transparent conductive laminate of Claim 1, wherein the conductive layer is formed on the other side of the fluorine-containing resin film, and both sides of the fluorine-containing resin film are submitted to surface treatment to improve adhesion of the film.
4. The transparent conductive laminate of Claims 2 or 3, further comprising a primer layer formed on the treated surface of the fluorine-containing resin film.
5. The transparent conductive laminate of any of Claims 1-4, wherein the flexural modulus is 1-100 kg/mm<sup>2</sup>.
6. The transparent conductive laminate of any of Claims 1-5, wherein the optical transmittance at a wavelength of 550 nm after heat treatment for 2 hours at 220°C in air is 80% or higher, and the heat treatment causes no change in appearance.
7. The transparent conductive laminate of any of Claims 1-6, wherein the moisture absorptivity of the fluorine-containing resin film is 0.1% or less.
8. A display wherein a gaseous, liquid, or solid display medium is held between a pair of transparent substrates, characterized in that at least one of the transparent substrates comprises the transparent conductive laminate of any of Claims 1-7.
9. The display of Claim 8, wherein the display medium comprises liquid crystals.

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10. The display of Claim 9, having a polymer structure disposed between the substrates and designed to keep the space between the substrates uniform.

11. The display of Claim 8, wherein the display medium is composed of minute electrophoretic particles dispersed in a dispersant so that the state of absorption of outside light changes when the minute particles move or rotate when a voltage is applied.

12. The display of Claim 8, wherein the display medium is composed of a metal ion-containing electrolyte, and deposition and dissolution of the metal in the electrolyte is controlled by current injection so that the state of absorption of outside light changes.

13. The display of Claim 8, wherein the display medium is composed of an organic thin film that has an electroluminescent effect or a resin film with an inorganic fluorescent material dispersed therein so that luminescence is produced by the injection of electric current or the application of voltage.

14. A display having a display medium made of thin film laminated on a transparent substrate, characterized in that the transparent substrate comprises the transparent conductive laminate of any of Claims 1-7.